PROTECTIVE IRRIGATION WOR

RAJPUTANA.

REPORT

ON THE

BHULA PROJECT, NEAR ROHERA,

IN THE

SIROHI STATE.

AJMER:
PRINTED AT THE RAJPUTANA MISSION PRESS.
1901.

INDEX.

PLANS.

SIROHI STATE.

BHULA PROJECT, NEAR ROHERA.

Source and Course of the Nullah.

1. Seven nullahs which rise and have a drainage area of 35 square miles in the Aravellis, unite and pass through a low range of hills near Bhula, which is about 3 miles south-east of the village of Rohera. The nullah so formed joins the left bank of the large Waloria Nullah at Rohera, then passes on in a south-west direction for 9 miles, till it flows into the left bank of the Western Banas at Kivarli.

Work started in the Famine of 1900.

2. During the Famine of 1900 work was begun on the construction of a Dam across the gap in the hills near Bhula, but all that exists is a deep trench which was dug for the foundations of the core-wall, and some 59,000 c.ft. of broken stone ballast stacked at the site, for concrete; and some concrete consolidated at the north end.

The value of this ballast at Rs. 3 per 100 c.ft. has been credited in the Estimate, as it can be used in the concrete foundations whenever the work is taken in hand.

Water available for storage

3. From the 35 square miles of hilly catchment it would be safe to anticipate that 20 per cent. of the average rainfall of 23½ inches is availabe for storage, or 383 m.c.ft.

Cost of original Project.

4. As the Famine work had been carried out without any Plans and Estimate, Surveys were taken to see what it would cost to complete the work, and it was found that with weir level at 40 ft. above bed of nullah, giving a capacity of 320 m.c.ft., the approximate cost for Dam, Weir, and Sluices would be Rs. 1,45,000.

The Dam would have been about 1,400 r.ft. in length, including a length of 310 r.ft. at the north end, where it was proposed to make a masonry Dam to serve as a waste weir, partly cut into the hill side.

Disadvantages of Site

5. The disadvantages of the site are :—

(*a*) The unsatisfactory nature of the soil at the site of the bund, necessitating a deep masonry core-wall, and great expense.

(*b*) The difficulty of getting a good escape.

(*c*) The large area of land below already irrigated by wells.

Site inspected by Consulting Engineer for Irrigation, and directions given by him.

6. The Consulting Engineer for Irrigation inspected the site in November 1903, and pointed out these defects to the Project, and directed Surveys to be taken to ascertain—

(*a*) The area and value of the land which will be submerged.

(*b*) The area of the land commanded; how much of this is already cultivated; and how much is watered by wells.

(*c*) And with the information so obtained to complete the Project, in case the work should be carried out later, and some use made of the expenditure incurred.

Land available for Irrigation.

7. This Survey has now been done, and it is found that—

(*a*)

	Wells.	Area already Irrigated by wells.	Area available for Irrigation.
		Acres.	*Acres.*
On left bank of nullah ...	38	359	778
On right bank of „ ...	42	299	443
Total ...	80	658	1,221

(*b*) With Weir level R.L. 140 (Weir level originally proposed), 7 wells and 32 acres of land irrigated by wells will be submerged; but that with weir level at 130 only 3 wells and 13 acres of well land are submerged.

To irrigate the land available, the storage reservoir should therefore be constructed with a capacity of not less than 122 m.c.ft., allowing 100,000 c.ft. of water per acre.

Storage capacity at different contours.

8. The following table shows the waterspread area, and contents of the storage reservoir at different contours. R. L. 100 has been taken to be bed level of the nullah at site of Dam:—

R.L.	Waterspread s.ft.	Capacity in m.c.ft.
150	38,200,000	323·00
140	26,400,000	205·60
130	14,720,000	100·80
120	5,440,000	35·20
110	1,600,000	5 33
Bed level	.....	
	Total ...	669·93

Capacity of Storage Reservoir.

9. We shall, therefore, be on the safe side if we take R.L. 130 as Weir level, giving a capacity of 136 m.c.ft. available for irrigation. Rs. 2,150 has been provided in the Estimate as compensation for the 3 wells and 13 acres of well land which will be submerged.

10. The Weir will still have to be on the hill at the north end of the Dam where there is rock, as levels* show that there is no saddle in the range of hills, away from the Dam, low enough to cut away for the escape; but at the lower Weir levelnow proposed the objection to this position is reduced, though a water cushion will still be necessary, and has been provided.

The maximum discharge, by Dicken's Formula, on the catchment area of 35 square miles is 11,863 ft. per second, and with a 7 ft. discharge a Weir 185 ft. in length is required.

Flood level will be R.L. 137; and the top of Dam R.L. 141.

11. The Dam (see Plan No. 3) starts from the south end of the Weir, and is 1,063 ft. in length, closing the gap in the range of hills through which the nullah flows.

It will be of earth, with a core-wall of masonry in lime 1½ ft. in thickness at top, increasing 6 inches at every 5 ft. depth by 3" offsets on either side.

As no rock for foundations is available, the core-wall will be taken down 15 ft. below bed level, or half the depth of water against the Dam.

The earthwork in front of the core-wall starts at flood level with a terrace 5 ft. in width at top, and has a 3 to 1 slope.

This front slope and the 5 ft. terrace will be protected with a 1 ft. layer of stone-pitching on 6 inches of kunker.

The earthwork in rear starts 2 ft. below the top of the core-wall, is 10 ft. in width at top, and has a 2 to 1 slope (see Plan No. 4).

12. Two outlet Sluices are provided.

Outlet Sluice No

Sluice No. 1 is at the south end of the Dam, and Canal No. 1 leads from it to irrigate the 778 acres available on the left bank.

The design consists of two chambers, with a 1½ ft. diameter Sluice fixed in the main wall dividing them, capable of discharging 10·8 c.ft. per second with 1 ft. head; and at this rate the 78 m.c.ft. of water required for the 780 acres available would be discharged in three months.

But the Sluice must also be large enough to supply all the water required for the first watering for the area available within about 30 days, as the demand is simultaneous, and it is of no use offering water when the time is past.

If we allow 1 c.ft. of water on the area as required for one watering, to be delivered in 30 days of 12 working hours, we get $\frac{\text{Acres} \times \text{ft. per acre.}}{30 \times 12 \times 60 \times 60} = \frac{780 \times 43,560}{30 \times 12 \times 60 \times 60} = 26$ c.ft. per second as the discharge required.

With the mean head of 10 ft.—and the total area could not be irrigated with less water stored—the 1½ ft. diameter sluice will discharge 34·39 c ft. per second, so satisfies the requirements.

---

* *Note.*—The level of lowest Saddle is R.L. 167 or 37 ft. above Weir

13. The face wall of the outer chamber is provided with double grooves 1½ ft. apart for Sluice boards, into which planks can be put with earth rammed between to shut off the water at any time, so that the Sluice may be examined and repaired if necessary. An iron grating with vertical bars is also provided to prevent brushwood, or anything likely to block the pipe or valve, passing into the Sluice well.

Wing walls with steps have also been provided in continuation of the Sluice well.

Ladders, consisting of 1 inch round iron bars are to be fixed to the sides of each well to enable descent to the Sluice valves.

The Sluice will be of cast-iron with gun-metal faces, fitted with two valves, one outside the Sluice well, and the other inside, so that if one valve gets out of order the other can be closed at once and opened after the necessary repairs have been carried out. The valves to be opened by vertical rods with screwed heads.

The screw wheel at the top to show clearly how much the valve is open at any time.

A wooden platform on iron rails is provided from which to work the Sluices.

A masonry arched Sluice drain passes from the Sluice well under the Dam connected with Canal No. 1.

Canal No 1

14. Canal No. 1 has been surveyed for 3½ miles (see Plan No. II) for the first 2 miles, where it has a fall of 2 ft. per mile, the section required to discharge 26 c.ft. per second is 3 ft. bed width, and 3 ft. depth, with side slopes 1 to 1;

For the 3rd mile the fall is 3 ft. per mile and for this length the section will be 3 ft. bed width with 1¾ ft. depth; and for the last ½ mile where the fall is 4 ft. per mile, 3 ft. bed width and 2½ ft. depth.

Sluice No 2

15. Sluice No. 2 is in the masonry Dam at the north end of the Weir, and consists of a circular outer well of masonry (see Plan No. V) connected with the masonry Dam, and provided with an opening, up the face, 3 ft. in width, provided with an iron grating and grooves for boards, as in the face wall of Sluice No. 1.

The inner chamber is a circular well 6 ft. diameter, built in the masonry Dam, the Sluice, which is 1 ft. in diameter, being fixed in the wall dividing the 2 chambers, a sluice valve being in each; the water is discharged through a 1 foot diameter cast iron pipe built in the masonry Dam, connected with Canal No. 2.

The Sluice can discharge 5½ c.ft. per second with 1 ft. head, or the 45 m.c.ft. of water required for the 450 acres available in a little over 3 months.

With the mean head of 10 ft., it will discharge 15¼ c.ft. per second, which is sufficient to give 1 c.ft. of water over the whole 450 acres in 30 days of 12 working hours.

16. Canal No. 2 has been surveyed with a fall of 2 ft. per mile for 2¾ miles, where it tails into the Waloria Nullah. Canal No 2

To discharge 15¼ c.ft. per second, it will require a 4 ft. bed width, 2 ft. depth and side slopes of 1 to 1.

17. (*a*) Building stone is procurable at site. Materials

(*b*) Slabs will be brought from Pindwara, a distance of 10 miles.

(*c*) Kunker is available near Rohera, at a distance of 3 miles.

(*d*) Wood for fuel is procurable at site.

18. General Abstract of cost.

	Rs.
Dam	51,519
Weir	21,149
Lower Weir to form water cushion	8,051
Sluice No. 1	5,457
Sluice „ 2	927
Canal No. 1	2,474
Canal „ 2	1,160
Compensation	2,150
Total ...	92,957
Contingencies @ 5 per cent.	4,648
Total ...	97,605
Deduct value of 59,000 c.ft. ballast at site @ 3 Rs per 100 c.ft.	1,770
Total ...	95,835

19. It is an expensive Project, and the value of water stored is 1,419 c.ft. per rupee. Value of water stored

20 If all the land available, 1,221 acres, is brought under cultivation and irrigated, allowing Rs. 4/ per acre, an annual Revenue of Rs. 4,884 should be realized or slightly over 5. per cent. profit on the capital cost. Probable Revenue

21. The Surveys were made and Plans prepared by Subaverseer Luxmi Narain, under the directions and supervision of the Superintending Engineer, Protective Irrigation Works, Rajputana. Preparation of Project

---

SPECIFICATION.

22. All the dimensions of the Dam are given in the Plans and Estimate, which are to be strictly adhered to. Dimensions

23. The centre line and the side slopes to be marked out with trenches 1½ ft. broad and 1 ft. deep, showing permanently the inner and outer slopes, and the breadth of the top of the embankment. Marking out

24. The embankment will be carried out in layers not exceeding 9" in thickness carefully consolidated. Earthwork.

No clods of earth should on any account be allowed in the embankment.

No earth to be excavated within 200 ft. of either toe of the slopes.

Canals. 25. All the cutting to be done as per section, with required slopes in bed. All the excavated earth to be stacked in spoil banks, leaving a berm of 10 ft. (width to be reduced if valuable land is crossed) on either side of the canal.

Pitching. 26. The surface of the inner slope and the terrace at top to be protected by a layer of dry rubble stone 1 ft. thick over 6" of kunker.

Masonry. 27. The masonry of the core-wall, outlet sluices weir, &c., to be of rubble set in lime mortar; only hard and durable stones to be used; and the masonry to be kept wet during construction. All the stones to be hammer-dressed, and to break joint in the same as well as in the successive courses.

All stones are to be laid on their natural beds; where there is batter the beds of the stones are to be at right angles to the batter.

Hollows between the larger stones to be filled in with smaller ones completely embedded in mortar. No empty hollow to be left nor spaces filled wholly with mortar or rubbish where pieces of stones ought to have been inserted.

The faces of the masonry in contact with the earth to be left quite rough and those remaining exposed to be smoothed and pointed with lime mortar.

Concrete 28. The concrete to consist of 3 parts broken stones to 1 part lime mortar well mixed together before putting in foundations, and to be laid in 6 inch layers and well rammed.

Lime Mortar. 29. The lime to be of good hard kunker burnt in wood fuel; cowdung to be only used for igniting the fire and never to exceed more than 1 per cent.

The mortar to consist of 1 part of lime to 1½ parts clear sand or surkee.

F. ST.-G. MANNERS SMITH,
SUPERINTENDING ENGINEER,
Protective Irrigation Works, Rajputana.

AJMER :
13th August 1904.

ABSTRACT ESTIMATE OF COST.

Bhula Project near Rohera, in Sirohi State.

Quantity or No.	Items.	Rate.	Per.	Amount.	T
	DAM.	Rs.		Rs.	
190,884 c.ft	Excavation	8	1,000 c. ft.	1,527	
75,363 „	Concrete	10	100 „	7,536	
133,263 „	Masonry	18	100 „	23,987	
3,080,897 „	Earthwork	5	1,000 „	15,404	
102,159 „	Pitching	5	1,000 „	3,065	
	WEIR WITH WING WALL.				
64,577 „	Excavation, including Rock cutting	15	1,000 „	969	
14,940 „	Concrete	10	100 „	1,494	
109,812 „	Masonry	18	100 „	18,686	
	LOWER WEIR TO FORM WATER CUSHION				
43,088 „	Excavation, including Rock cutting	15	1,000 „	646	
750 „	Concrete	10	100 „	750	
28,570 „	Masonry	18	100 „	5,142	
10,692 „	Pitching	3	100 „	321	
17,028 „	Concrete blocks	7	100 „	1,192	
	SLUICE No. I.				
14,590 „	Excavation, including Rock cutting	15	1,000 „	219	
7,647 „	Concrete	10	100 „	765	
2,210 „	Masonry Foundation and Flooring	18	100 „	398	
15,872 „	Masonry Superstructure ...	18	100 „	2,857	
693 „	Arch Masonry	24	100 „	166	
517 s.ft.	Stone work	As. 8	s.ft.	259	
1 No.	Sluice valve 1½" diamr. ..	Rs. 350	each	350	
105 s.ft.	Iron Grating	„ 1	s.ft.	105	
69 c.ft.	Woodwork	„ 3	c.ft.	207	
58 r.ft.	Girders (Rails)	„ 1	r.ft.	58	
290 „	Rod Iron 1" diamr. for vertical ladders	As. 4	„	73	

Quantity or No.	Items.	Rate.	Per	Amount.
	SLUICE No. 2.—	Rs.		Rs.
1,898 c.ft	Excavation	15	1,000 c.ft.	29
2,160 „	Masonry (in excess of that included in weir)	18	100 „	389
103 s.ft.	Stone work	As. 8	s.ft.	52
1 No.	Sluice valve 1 ft. diamr. ...	Rs. 250	each	250
105 s.ft.	Iron Grating	1	s.ft.	105
13½ c.ft.	Wood work	3	c.ft.	41
58 r.ft.	Girders	1	r.ft.	58
290 „	Rod Iron	As. 4	„	73
	CANAL No. 1.—	Rs.		
293,375 c.ft.	Excavation	4	1,000 c.ft.	1,174
1 No.	Road crossings	300	each	300
2 „	Escapes	500	„	1,000
	CANAL No. 2.—			
165,000 c.ft.	Excavation	4	1,000 c.ft.	660
1 No.	Escapes	500	each	500
	COMPENSATION.—			
3 No.	Wells in tank	500	each	1,500
13	Acres of well land	50	acre.	650
	Total ...	...	...	...
	CONTINGENCIES	5	1,000 c.ft.	...
	Deduct value of 59,000 c.ft. ballast at site at	3	100 c.ft	...